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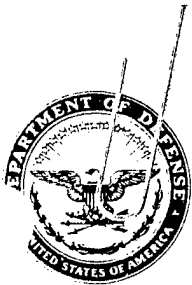
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DEPARTMENT OF THE AIR FORCE  
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE  
BROOKS AIR FORCE BASE TEXAS

23 Feb 95

MEMORANDUM FOR 66 SPTG/CEV  
ATTN: Mr. Robert Spelfogel  
120 Grenier Street  
Hanscom AFB, MA 01731-1910

FROM: HQ AFCEE/ERT  
8001 Arnold Drive  
Brooks AFB TX 78235-5357

SUBJECT: Completion of One Year Bioventing Test, Buildings 1639 and 1812

The Air Force Center for Environmental Excellence (AFCEE) one-year bioventing test and evaluation projects at Buildings 1639 and 1812 have been completed. For each site, Figure 1 provides general site information and Table 1 provides a summary of initial, six-month, and one-year fuel respiration and degradation rates measured at several monitoring points. Overall, for Building 1639, biodegradation rates have decreased over the one-year pilot test. These decreases are best explained by the reduction of contaminant levels as the bioventing continued. For Building 1812, the oxygen levels at monitoring point MPA seem to naturally remain elevated. It is possible that this monitoring point is in relatively uncontaminated soil and the vent well is in a relatively contaminated area. Table 2 provides a summary of initial and final soil and soil gas analytical results for total recoverable petroleum hydrocarbons (TRPH) and benzene, toluene, ethyl benzene, and xylenes (BTEX). Based on results from your sites and 123 other sites currently under operation, bioventing is cost-effectively remediating fuel contamination in a reasonable time frame. We recommend its application at other sites on your installation using the criteria in the AFCEE Test Plan and Technical Protocol for a Field Treatability Test for Bioventing, May 1992, including Addendum One, February 1994. These are found in the "Tool Box" recently sent to your base.

The objective of the one-year sampling effort was not to collect the large number of samples required for statistical significance. It was conducted to show relative reductions in TRPH and BTEX concentrations. Soil gas samples are somewhat similar to composite samples in that they are collected over a wider area. Thus, they provide a good indication of changes in soil gas profiles and volatile contaminant concentrations (see Addendum One to Test Plan and Technical Protocol for a Field Treatability Test for Bioventing - Using Soil Gas Surveys to Determine Bioventing Feasibility and Natural Attenuation Potential, February 1994). Soil samples, on the other hand, are discrete point samples subject to large variabilities over small distances/soil types. Given this variability, coupled with known sampling and analytical variabilities, a large number of samples would have to be collected to conclusively determine "real" changes in soil contamination. Because of the limited number of samples, these results should not be

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viewed as conclusive indicators of bioventing progress or evidence of the success or failure of this technology. In situ respiration tests are considered to be better indicators of hydrocarbon remediation than limited soil sampling.

The soil analytical results for Building 1639 are not conclusive. Both the initial and one-year soil analysis for this site indicate low contamination levels. However, one-year point soil gas analytical results for Building 1639 indicate overall decreasing TVH and BTEX in the soils within the treatment radius of the pilot vent well. The one-year point respiration tests indicate some degradation is occurring at Building 1639. We recommend that the system continue to operate until respiration tests indicate background respiration rates for clean soils. Additional respiration testing and system expansion to cover the entire site can be contracted through AFCEE. Please contact Jerry Hansen, AFCEE/ERT, DSN 240-4353, COM 210-536-4353, to discuss technical and contractual options for full-scale expansion.

The soil analytical results for Building 1812 indicate TRPH contamination remains at the vent well. However, BTEX levels have been reduced to a low level at the vent well. It appears that the contamination at this site may be localized near the vent well. This conclusion is based on the naturally elevated oxygen levels at monitoring point MPA. The state of Massachusetts has site specific cleanup standards. The Building 1812 site appears to be at contaminant levels below the state requirements. We have on contract the ability to do site closure soil sampling for the Building 1812 site. We will be contacting you to schedule the closure sampling.

Data from your base and many others indicate that BTEX compounds are preferentially biodegraded over TRPH. Since BTEX compounds represent the most toxic and mobile fuel constituents, a BTEX standard is a risk-based standard. We strongly encourage its use over an arbitrary TPH standard. Within the AFCEE Risk-based Petroleum Hydrocarbon "Tool Box," the reported entitled "Use of Risk-based Standards for Cleanup of Petroleum Contaminated Soil," summarizes the BTEX/TPH issue and will assist you in negotiating for a BTEX cleanup standard.


In general, quantitative destruction of BTEX will occur over a one- to two-year bioventing period. Soil gas surveys and respiration tests can be used as BTEX destruction indicators. If a non-risk-based/TRPH cleanup is chosen, the pilot and full-scale systems should be operated until respiration rates approach background rates. We recommend that confirmatory soil sampling be conducted four to six months after background respiration rates are approached.

Because this is a streamlined test and evaluation project, our contract does not provide for additional reports to the base on pilot study results. The interim results report contains as-builts and initial data. This letter summarizes all data collected and provides next step recommendations. AFCEE is no longer responsible for the operation, maintenance, or monitoring of the bioventing systems. We are initiating a contract to extend monitoring at some sites beyond the initial one-year test. Monitoring

will include soil gas and respiration tests to document hydrocarbon degradation, but may also include the collection of sufficient final soil samples to statistically demonstrate site cleanup. If you are interested, please call us.

The blower and accessories are now base property and should continue to be used on this or other bioventing sites. Although current equipment is explosion proof, under no circumstances should it be used for soil vapor extraction unless appropriate explosion-proof wiring is provided. If the base does not want to keep the blower or if you have further questions, please contact us.

On behalf of the AFCEE/ERT staff, I would like to thank you for your support of these bioventing test and evaluation projects. The information gained from each site will be invaluable in evaluating this technology and will promote its successful application on other DOD, government, and private sites. I have attached a customer satisfaction survey. Please take a few minutes to fill it out and tell us how we did. We look forward to hearing from you.

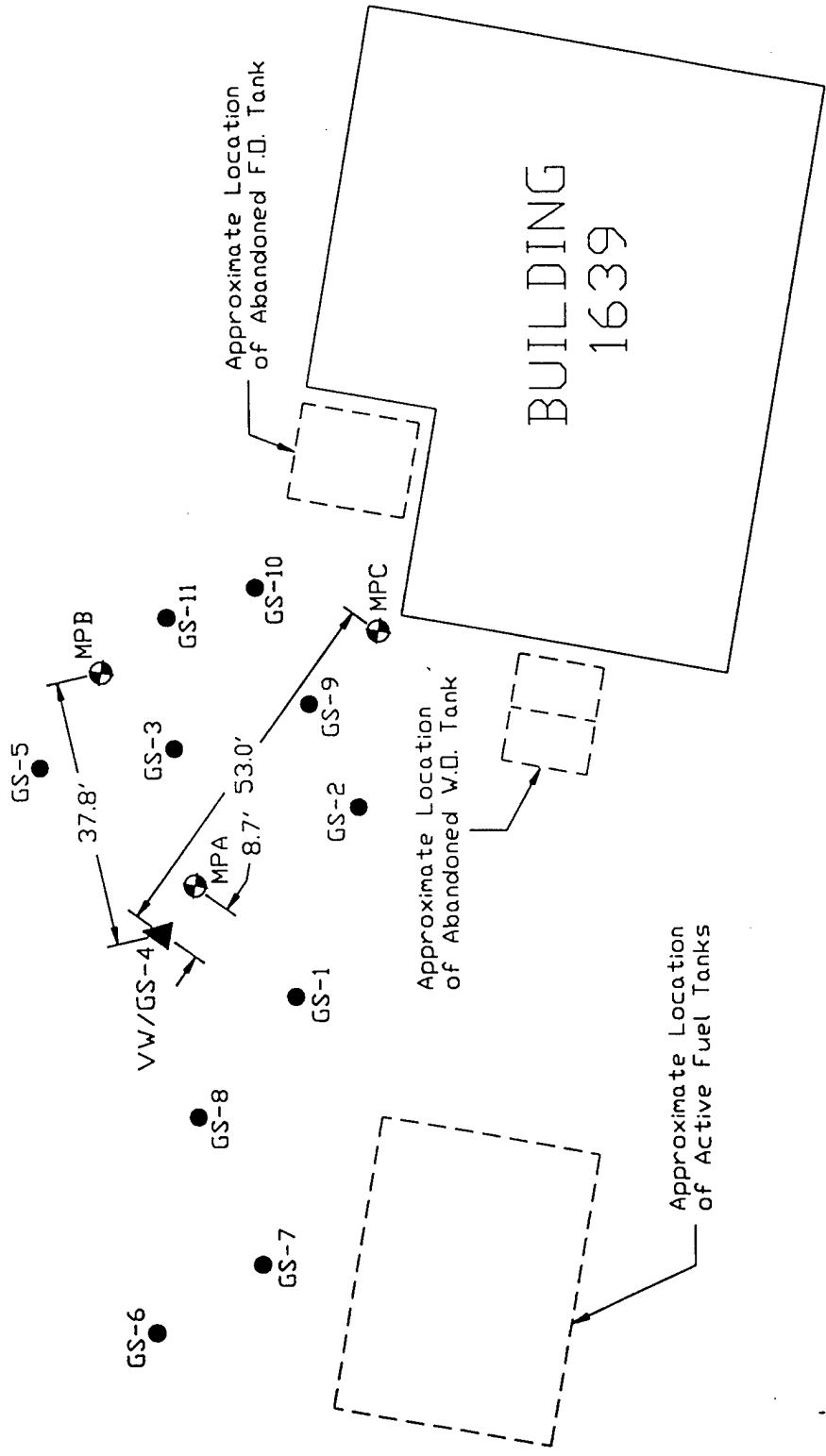


ROSS N. MILLER, Lt Col, USAF, BSC  
Chief, Technology Transfer Division

Attachments:

1. Building 1639 Data
2. Building 1812 Data
3. Survey

cc: AFCEE/ERD (Mr. Saulnier)  
HQ AFMC/CEV  
Engineering Science



Not to scale

# LEGEND

- ▲ INJECTION VENT WELL
- ⊕ VAPOR MONITORING POINT
- SOIL GAS SURVEY POINT

FIGURE 1

## BUILDING 1639 AS-BUILT SITE PLAN

HANSCOM AFB, MASSACHUSETTS

**ENGINEERING-SCIENCE, INC.**

Denver, Colorado

**TABLE 1**  
**BUILDING 1639**  
**RESPIRATION AND DEGRADATION RATES**  
**HANSCOM AFB, MASSACHUSETTS**

Location - Depth	Initial (October 1992) <sup>a/</sup>			6 - Month (June 1993)			1 - Year (March 1994) <sup>b/</sup>		
	K <sub>o</sub> (% O <sub>2</sub> /min)	Degradation Rate (mg/kg/year) <sup>c/</sup>	Soil Temperature (°C)	K <sub>o</sub> (% O <sub>2</sub> /min)	Degradation Rate (mg/kg/year) <sup>d/</sup>	Soil Temperature (°C)	K <sub>o</sub> (% O <sub>2</sub> /min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA - 2.5	NS <sup>e/</sup>	NS	18.6	0.000062	18	20.4	NS	NS	NS <sup>f/</sup>
MPA - 5	0.023	9800	19.7	0.0085	1200	19.0	0.00060	140	NS <sup>f/</sup>
MPB - 2.5	0.0070	2900	NS	NS <sup>g/</sup>	NS <sup>g/</sup>	NS	0.00023	51	NS
MPB - 5	0.0097	4000	NS	NS <sup>g/</sup>	NS <sup>g/</sup>	NS	0.00017	40	NS
MPC - 6	0.012	4700	NS	NS <sup>h/</sup>	NS <sup>h/</sup>	NS	0.0022	520	NS

<sup>a/</sup> Initial testing and calculations were performed by Battelle.

<sup>b/</sup> 1 - Year respiration test was performed approximately 30 days after blower system was shut off.

<sup>c/</sup> Milligrams of hydrocarbons per kilogram of soil per year.

<sup>d/</sup> Assumes moisture content of the soil is average of initial and final moistures.

<sup>e/</sup> NS = Not Sampled.

<sup>f/</sup> Thermocouple leads were destroyed by ice in well head.

<sup>g/</sup> Respiration test was not performed at this point due to water in monitoring points.

<sup>h/</sup> Respiration test was not performed at this point due to initial oxygen concentration in point being 0.0 percent.

TABLE 2  
BUILDING 1639  
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS  
HANSCOM AFB, MASSACHUSETTS

Analyte (Units) <sup>a/</sup>	Sample Location – Depth (feet below ground surface)											
	MPA-2.5		MPA-5		MPB-2.5		MPB-5		MPC-3.5		MPC-6	
	Initial <sup>b/</sup>	1–Year <sup>c/</sup>	Initial	1–Year	Initial	1–Year	Initial	1–Year	Initial	1–Year	Initial	1–Year
Soil Gas Hydrocarbons												
TVH (ppmv)	5600	130	19000	16	2700	59	3200	19	280	1500	11000	9800
Benzene (ppmv)	5.2	0.21	27	<0.002	2.8	0.32	2.4	0.11	0.44	<0.05	11	49
Toluene (ppmv)	4.2	<0.002	35	<0.002	1.3	1.7	0.84	0.35	0.13	7.0	20	45
Ethylbenzene (ppmv)	1.1	0.035	10	0.006	0.84	0.11	0.42	0.044	0.11	1.0	9.3	1.6
Xylenes (ppmv)	2.9	0.058	30	0.011	1.9	2.5	1.5	0.97	0.37	8.7	67	21
Soil Hydrocarbons												
TRPH (mg/kg)	22	39.3	15	310	<4	26						
Benzene (mg/kg)	0.048	0.0081	0.67	<0.0006	1.0	0.086						
Toluene (mg/kg)	0.020	0.02	0.27	0.0022	4.3	0.16						
Ethylbenzene (mg/kg)	0.013	0.0088	0.43	0.0015	1.3	0.21						
Xylenes (mg/kg)	0.020	0.013	0.45	0.0096	12	0.89						
Moisture (%)	22.2	20.7	21.8	12.2	5.8	13.0						

a/TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume;

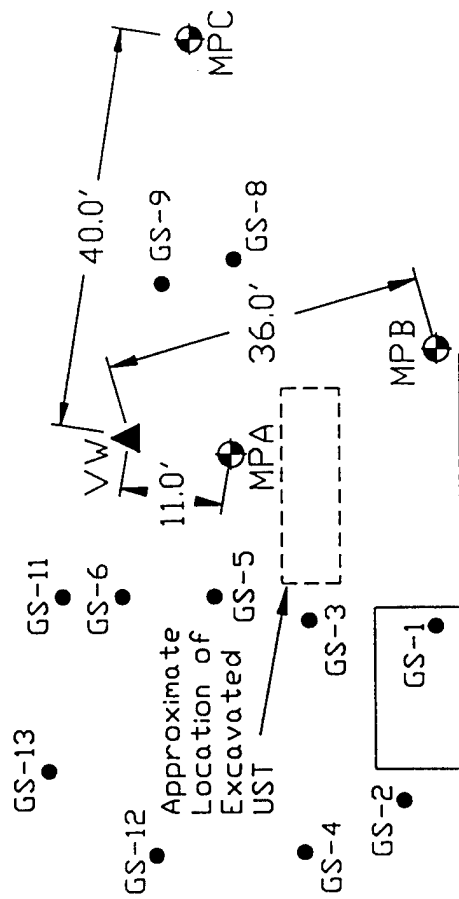
TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram.

b/Initial soil gas samples collected on 10/12/92.

c/ 1-Year soil gas samples collected on 3/8/94.

d/Initial soil samples collected on 10/2/92.

e/ 1—Year soil samples collected on 3/23/94.



# BUILDING 1812

Not to scale

## LEGEND

- ▲ INJECTION VENT WELL
- ⊕ VAPOR MONITORING POINT
- SOIL GAS SURVEY POINT

FIGURE 1

## BUILDING 1812 AS-BUILT SITE PLAN

HANSCOM AFB, MASSACHUSETTS

**ENGINEERING-SCIENCE, INC.**

Denver, Colorado



**TABLE 1**  
**BUILDING 1812**  
**RESPIRATION AND DEGRADATION RATES**  
**HANSCOM AFB, MASSACHUSETTS**

Location -- Depth	Initial (Oct. 1992) <sup>a/</sup>			6 -- Month (June 1993)			1 -- Year (March 1994) <sup>d/</sup>		
	K <sub>o</sub> (% O <sub>2</sub> /min)	Degradation Rate (mg/kg/year) <sup>b/</sup>	Soil Temperature (°C)	K <sub>o</sub> (% O <sub>2</sub> /min)	Degradation Rate (mg/kg/year) <sup>c/</sup>	Soil Temperature (°C)	K <sub>o</sub> (% O <sub>2</sub> /min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA -- 2.5	NS <sup>e/</sup>	NS	NS	0.00081	320	19.7	NS	NS	NS
MPA -- 5	NS	NS	NS	0.00039	170	17.2	NS	NS	NS

<sup>a/</sup> Initial testing was not performed by Battelle due to high oxygen concentrations.

<sup>b/</sup> Milligrams of hydrocarbons per kilogram of soil per year.

<sup>c/</sup> Assumes moisture content of the soil is average of initial and final moistures.

<sup>d/</sup> 1 -- Year testing was not performed at this site due to atmospheric oxygen concentrations in soil gas 30 days after blower system was shut down.

<sup>e/</sup> NS = Not Sampled.

**TABLE 2**  
**BUILDING 1812**  
**INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS**  
**HANSCOM AFB, MASSACHUSETTS**

Analyte (Units) <sup>a/</sup>	Sample Location – Depth (feet below ground surface)																																				
Soil Gas Hydrocarbons	NO SOIL GAS DATA COLLECTED <sup>b/</sup>																																				
Soil Hydrocarbons	<table><tr><th colspan="2">VW (3–3.5)</th><th colspan="2">VW (3.5–4.5)<sup>c/</sup></th></tr><tr><th>Initial<sup>d/</sup></th><th>1–Year<sup>e/</sup></th><th>Initial</th><th>1–Year</th></tr><tr><td>TRPH (mg/kg)</td><td>12</td><td>658</td><td>13000</td><td>2860</td></tr><tr><td>Benzene (mg/kg)</td><td>&lt;0.062</td><td>&lt;0.0006</td><td>&lt;0.0032</td><td>&lt;0.063</td></tr><tr><td>Toluene (mg/kg)</td><td>&lt;0.072</td><td>0.0013</td><td>0.015</td><td>&lt;0.063</td></tr><tr><td>Ethylbenzene (mg/kg)</td><td>&lt;0.052</td><td>&lt;0.0006</td><td>&lt;0.0026</td><td>&lt;0.063</td></tr><tr><td>Xylenes (mg/kg)</td><td>&lt;0.093</td><td>0.001</td><td>0.051</td><td>&lt;0.088</td></tr></table>				VW (3–3.5)		VW (3.5–4.5) <sup>c/</sup>		Initial <sup>d/</sup>	1–Year <sup>e/</sup>	Initial	1–Year	TRPH (mg/kg)	12	658	13000	2860	Benzene (mg/kg)	<0.062	<0.0006	<0.0032	<0.063	Toluene (mg/kg)	<0.072	0.0013	0.015	<0.063	Ethylbenzene (mg/kg)	<0.052	<0.0006	<0.0026	<0.063	Xylenes (mg/kg)	<0.093	0.001	0.051	<0.088
VW (3–3.5)		VW (3.5–4.5) <sup>c/</sup>																																			
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Xylenes (mg/kg)	<0.093	0.001	0.051	<0.088																																	
Moisture (%)	3.2	5.7	6.1	0.5																																	

<sup>a/</sup> TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.

<sup>b/</sup> No soil gas samples were collected from this site.

<sup>c/</sup> Initial soil sample taken from 3.5-4 feet bgs, 1-year soil sample taken from 4-4.5 feet bgs.

<sup>d/</sup> Initial soil samples collected on 10/3/92.

<sup>e/</sup> 1-Year soil samples collected on 3/23/94.

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